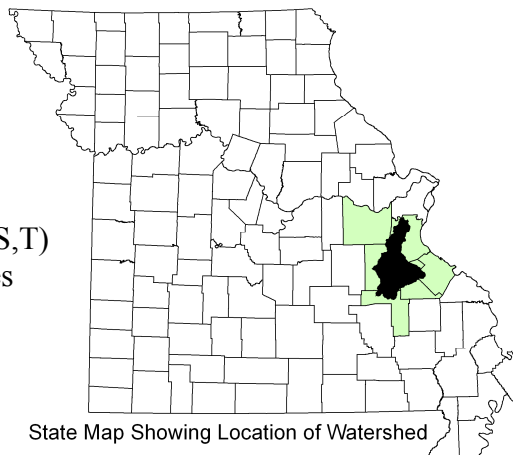


Total Maximum Daily Load Information Sheet

Big River, Flat River Creek and Tributary

Water Body Segment at a Glance:

County: St. Francois/Jefferson
Nearby Cities: Leadwood to Eureka
Length of impaired segment: Big River - 68 miles
Water Body ID: 2080
Pollutants: Cadmium (S)¹, Zinc (S), Lead (S,T)
Length of impaired segment: Flat River Creek – 9 miles
Water Body ID: 2168
Length of impairments within 2168: Cadmium (W) – 9 miles
Lead (S,T) – 6 miles
Source: Mill tailings (Abandoned)
Length of impaired segment: Tributary to Flat River Creek (unclassified) – 0.3 mile
Water Body ID: 2168U-01
Pollutant: Zinc (W)
Source: Mill tailings (Abandoned)



State Map Showing Location of Watershed

Note: See also the Big River Information Sheet and approved TMDL for lead (W) and non-volatile suspended sediment for all segments, and zinc (W) in Flat River Creek².

Scheduled for TMDL Development: 2012

Description of the Problem

Beneficial uses of both Big River and Flat River Creek:

- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life
- Human Health Protection (Fish Consumption)
- Whole Body Contact Recreation

Tributary to Flat River Creek (WBID 2168U-01) is unclassified and, therefore, has no beneficial uses assigned to it.

Uses that are impaired:

- Protection of Warm Water Aquatic Life
- Human Health Protection (Fish Consumption)
- General Criteria

¹ (S) = in sediment/soil; (T) = in fish tissue; (W) = in water as dissolved metal

² The TMDL was approved by the U.S. Environmental Protection Agency 3/24/10. It can be viewed at: www.dnr.mo.gov/env/wpp/tmdl/wpc-tmdl-EPA-Appr.htm

Standards that apply:

- Missouri Water Quality Standards for metals found in 10 CSR 20-7.031(4)(B)1 state:
Water contaminants shall not cause the criteria in Tables A and B to be exceeded.
Concentrations of these substances in bottom sediments or waters shall not harm benthic organisms and shall not accumulate through the food chain in harmful concentrations, nor shall state and federal maximum fish tissue levels for fish consumption be exceeded.
- Missouri does not have specific numeric criteria for metals in sediment. Likewise, the U.S. Environmental Protection Agency has not yet established federal guidelines for toxic chemicals in stream or lake sediments. In lieu of such criteria, Probable Effect Levels suggested by McDonald, et. al³, are used. PELs are the concentrations at which some toxic effect on aquatic life is likely
- Current zinc criteria (Table A) for the protection of aquatic life use are expressed in dissolved form. They are hardness dependent and are calculated from these formulas:

Dissolved Zinc

$$\text{Chronic} = e^{(0.8473 \cdot \ln(\text{hardness}) + 0.785)} * 0.978 = \mu\text{g/L}$$

$$\text{Acute} = e^{(0.8473 \cdot \ln(\text{hardness}) + 0.8842)} * 0.986 = \mu\text{g/L}$$

- In addition, Missouri has general, or narrative, criteria found at WQS, 10 CSR 20-7.031(3). The particular criteria that apply to these water body segments include:
 - (D) Waters shall be free from substances or conditions in sufficient amounts to result in toxicity to human, animal or aquatic life.
 - (G) Waters shall be free from physical, chemical or hydrologic changes that would impair the natural biological community.
 - (I) Waters in mixing zones and unclassified waters which support aquatic life on an intermittent basis shall be subject to the following requirements:
 1. The acute toxicity criteria of Tables A and B and the requirements of subsection (4)(B).

Background information and water quality data:

Big River is impaired by erosion of tailings directly from the Leadwood, Desloge and Bonne Terre chat piles, as well as tailings entering from Flat River Creek. Tailings are the part of washed or milled mineral ore considered too poor to be treated further. In other words, they are the ground-up rock (predominantly sand-sized pieces of limestone) left over after extracting the desired minerals (in this case lead and zinc). The problem is, these tailings are contaminated; they still contain enough of the mined metals that they are harmful to aquatic life and humans. A separate problem is that the eroded tailings cover up the gravel bottom of the river, eliminating habitat for aquatic creatures, and fill in natural fishing and swimming pools, changing the very nature of the river.

Flat River Creek is a tributary to Big River. It has been impaired by three sources:

- Erosion of lead tailings from the Federal tailings pond (St. Joe State Park).
- Erosion of tailings from the National pile which adjoins the Flat River Glass Company.
- Erosion of tailings and discharge of dissolved zinc from the Elvins tailings pile.

³ *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems*, D. MacDonald, et al., 2000

The unnamed tributary enters Flat River Creek downstream of Elvins. It is contaminated by dissolved zinc.

These piles are being remediated and the erosion of the tailings has nearly been eliminated. However, contamination of stream sediments over the years has led to the contamination of fish and other aquatic life. New studies are showing that the lead and other metals in these tailings are toxic to mussels, crayfish and other small invertebrates that inhabit the bottom of the river. It is already known that lead bioaccumulates in the bodies of aquatic creatures, which has been documented in the levels of lead in fish in Big River.

Sediment data

Evidence for impairment is based on data gathered by USGS and the Department from 1997-2007 (Figures 1-4 above). These graphs show levels of cadmium, zinc and lead in Big River sediment and lead in Flat River Creek.

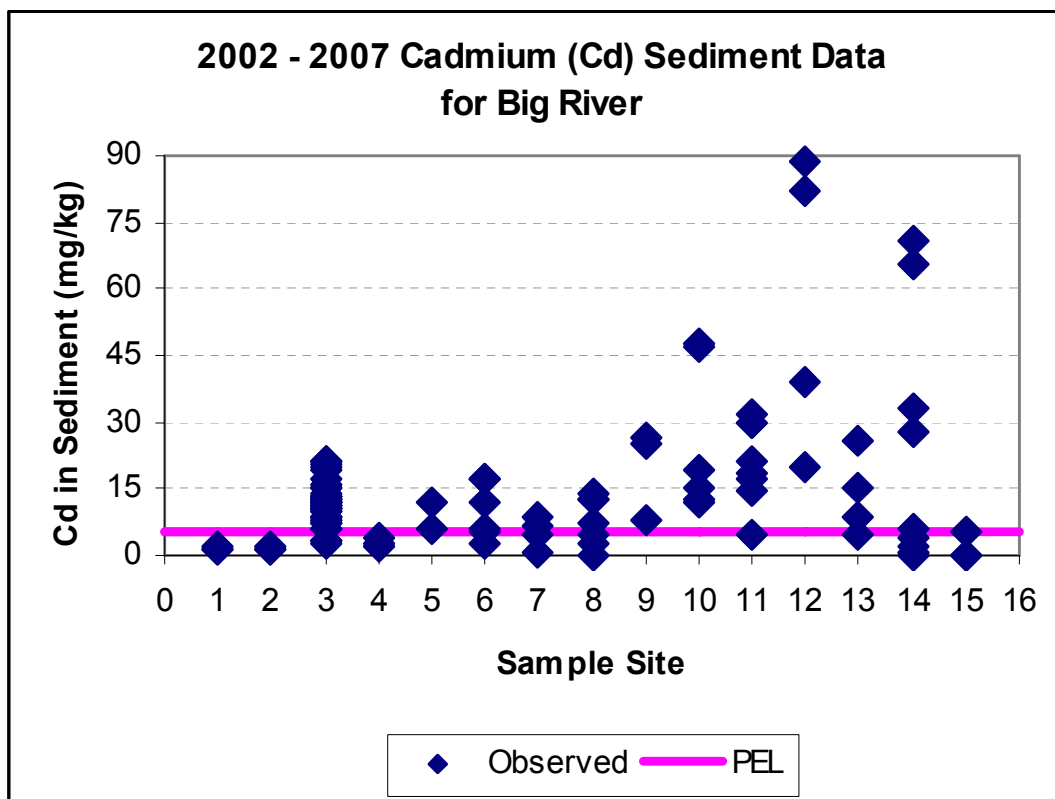


Figure 1

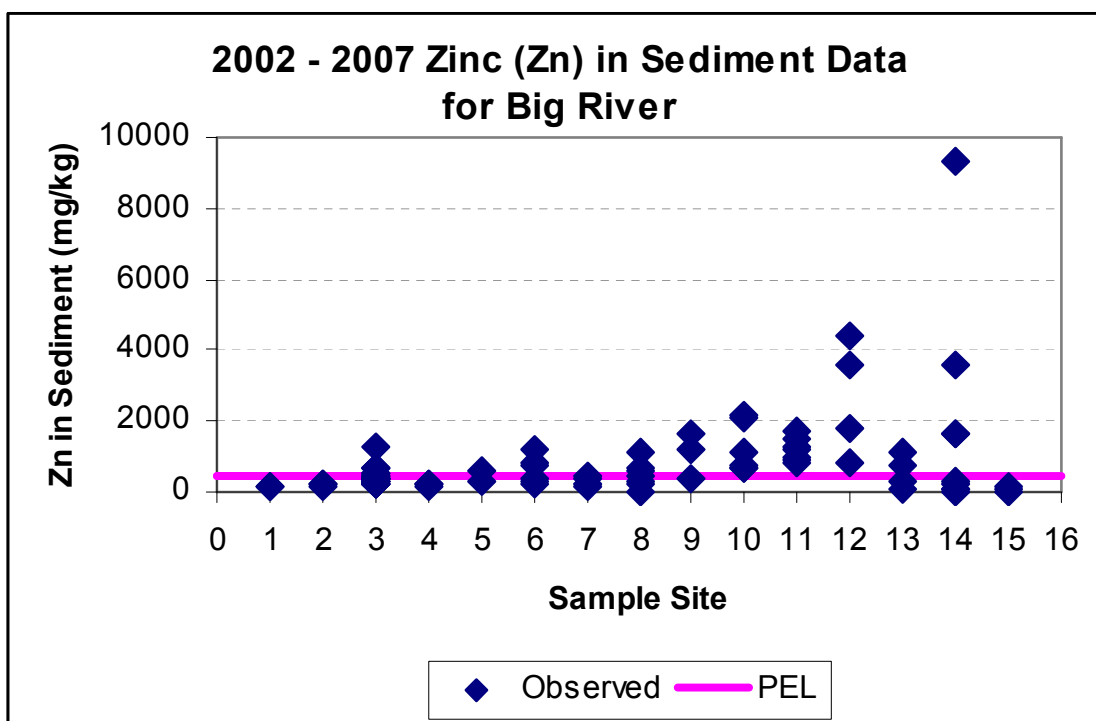


Figure 2

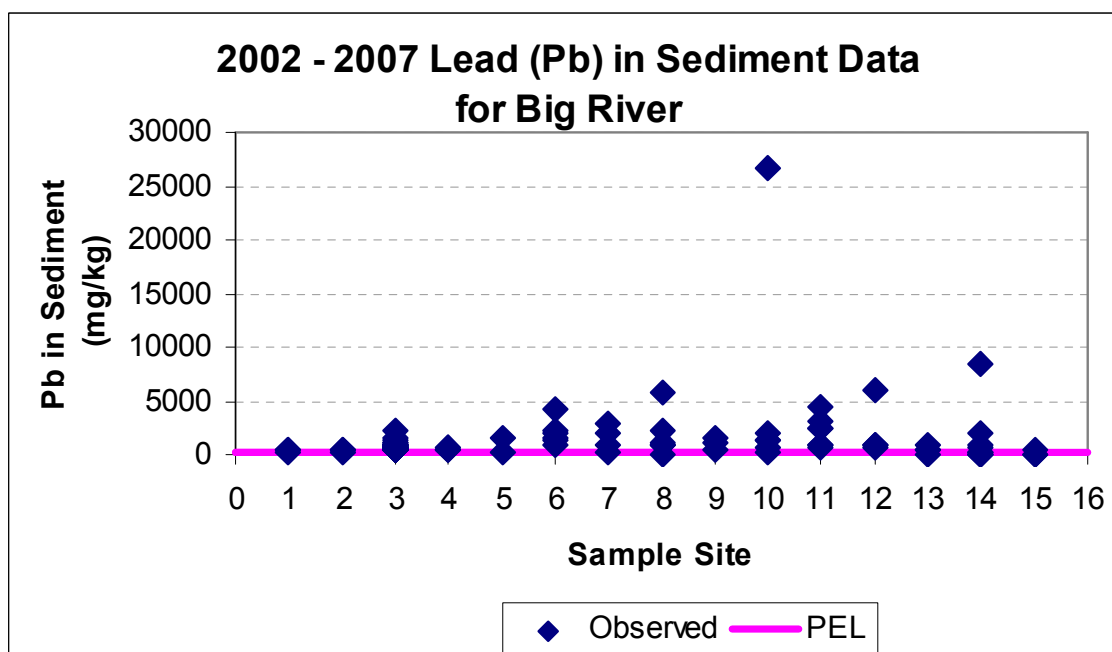


Figure 3

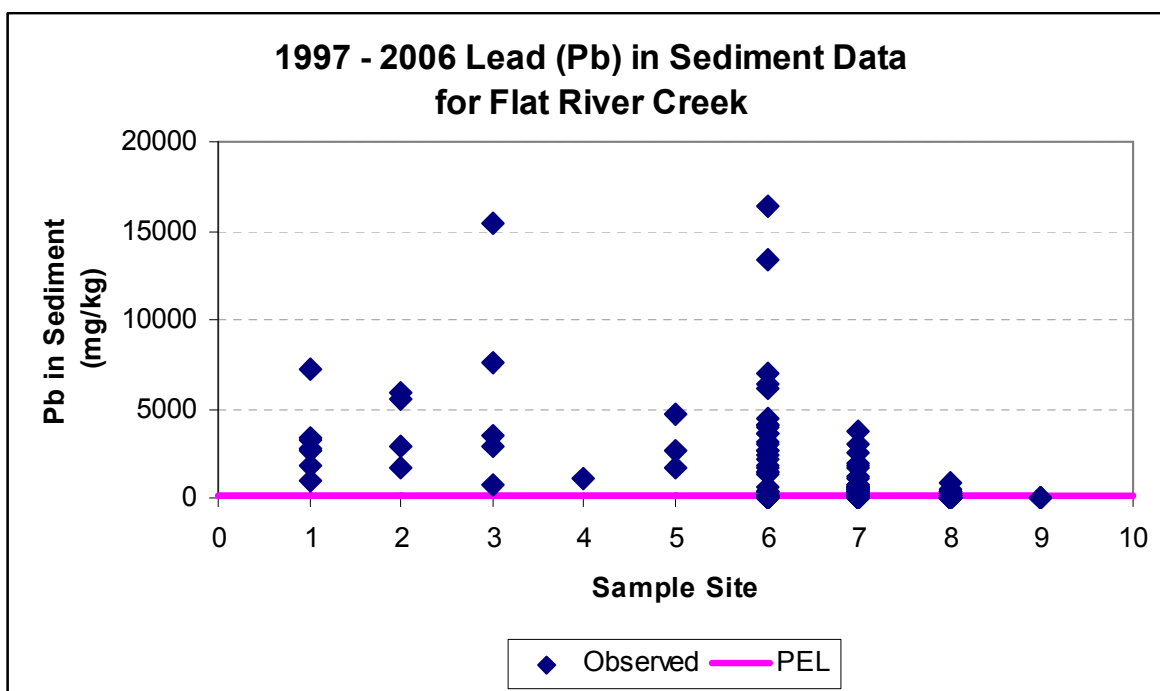


Figure 4

Fish tissue data

Fish and other aquatic life also have accumulated elevated levels of lead in their bodies due to dissolved lead draining from the old tailings. Ninety-three miles of Big River, from Leadwood to the river's mouth, and the lower six miles of Flat River Creek are under a Missouri Department of Health and Senior Services (DHSS) advisory recommending no consumption of sunfish, carp or suckers due to lead contamination of these fish. DHSS also has a 0.3 mg/kg criterion for lead in the edible portions of fish. Department data and data collected by the Missouri Department of Conservation (MDC) near De Soto showed exceedances of this standard (see Table 1). Likewise, fish tissue collected by MDC from Flat River near the stream's mouth and near Derby also showed exceedances of the DHSS 0.3 mg/kg criterion (see Table 2).

Table 1. Department and MDC Lead in Fish Tissue Data from Big River near De Soto, Mo.

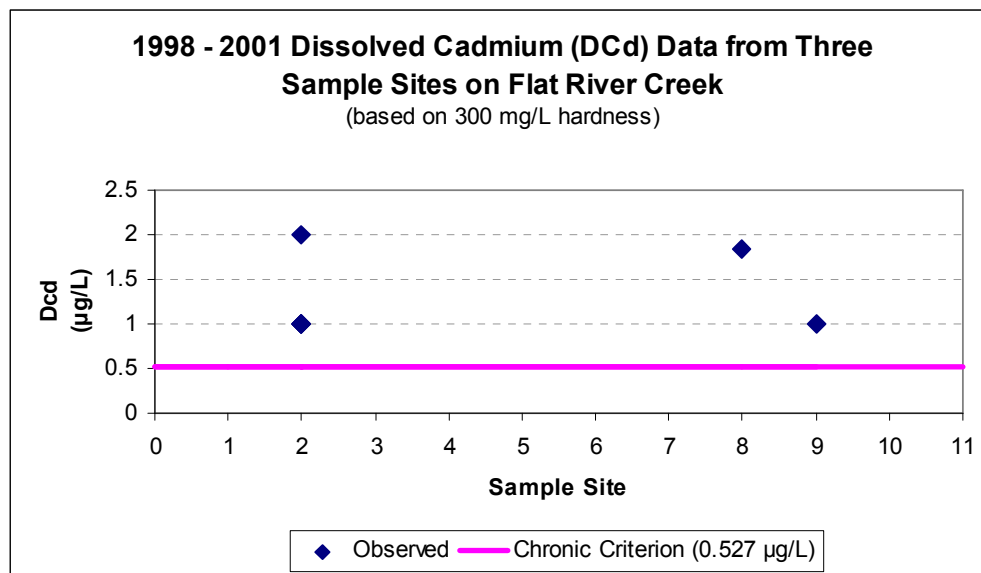
Year	Species	# in Sample	Preparation	Length, in.	Weight, lbs.	Fat, %	Pb, mg/kg
1999	smallmouth bass	3	fillet		1.25		0.308
1999	golden redhorse	5	fillet		1.19		0.695
2001	Kentucky bass	15	fillet		0.9		0.08
2002	golden redhorse	5	fillet		0.8		0.326
2002	Kentucky bass	4	fillet		0.7		0.085
2005	longear sunfish	5	fillet	5.2	0.1		0.1923
2005	longear sunfish	5	fillet	5.1	0.1		0.3208
2005	longear sunfish	5	fillet	5.5	0.1		0.4167
2005	golden redhorse	5	fillet	11.7	0.6	2	0.6722
2005	golden redhorse	5	fillet	12.4	0.7	1	0.6101
2005	golden redhorse	5	fillet	12.3	0.8	1	0.5733
Average:							0.389
DHSS Criterion:							0.300

Table 2. MDC Lead in Fish Tissue Data from Flat River near the mouth and near Derby, Mo.

Year	Species	# in Sample	Preparation	Length, in.	Weight, lbs.	Fat, %	Pb, mg/kg
1996	sucker	14	fillet	0.3	0.3	2	0.066
1996	sunfish	17	fillet	0.1	0.1	0	0.03
1998	sunfish	7	fillet	0.2	0.2		0.7
2000	sunfish	15	fillet	0.1	0.1		0.6
1995	black redhorse	15	fillet	0.7	0.7	1	0.66
1995	sunfish	15	fillet	0.1	0.1	1	0.56
1996	sucker	13	fillet	0.6	0.6	1	0.45
1996	sunfish	15	fillet	0.1	0.1	1	0.5
2000	bass	15	fillet	0.5	0.5		0.05
2000	sucker	15	fillet	0.6	0.6		0.46
2000	sunfish	15	fillet	0.2	0.2		0.36
Average:							0.403
DHSS Criterion							0.300

Water data

In addition to cadmium and zinc contamination of sediment and lead contamination in fish, water draining from the Elvins chat pile in Elvins has caused high levels of dissolved cadmium in Flat River Creek (Figure 5) and dissolved zinc in a tributary to Flat River Creek (Figure 6). During low flow periods, there has been enough zinc in the drainage from the chat pile to cause levels of zinc in this water body to exceed state water quality standards for toxicity to aquatic life. Because compounds of zinc are generally soluble in neutral and acidic solution, zinc is readily transported in most natural waters and is one of the most mobile of the heavy metals. Hardness, dissolved oxygen, temperature and synergistic effects (more than the sum of the individual components) with other compounds all affect the toxicity of zinc to aquatic life⁴. Zinc is an essential nutrient to aquatic and terrestrial organisms, but in excess can be highly toxic and has the tendency to bioaccumulate (build up in organisms) in the environment.

**Figure 5**

⁴ Upper Sacramento River TMDL for Metals. California Environmental Protection Agency, 9/25/01.
www.waterboards.ca.gov/centralvalley/programs/tmdl/TMDL%20Final%20Report_2002Apr.pdf

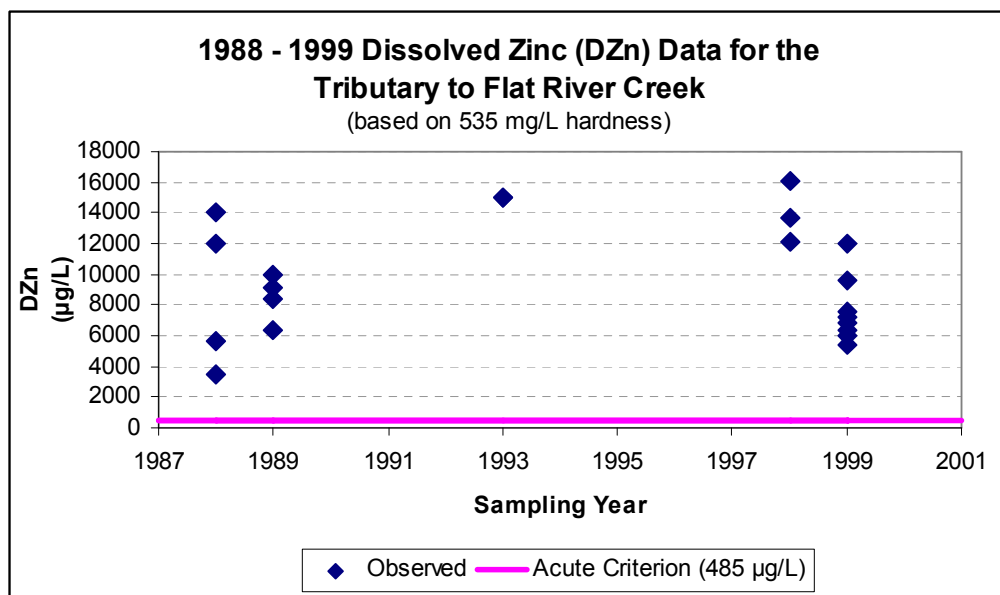
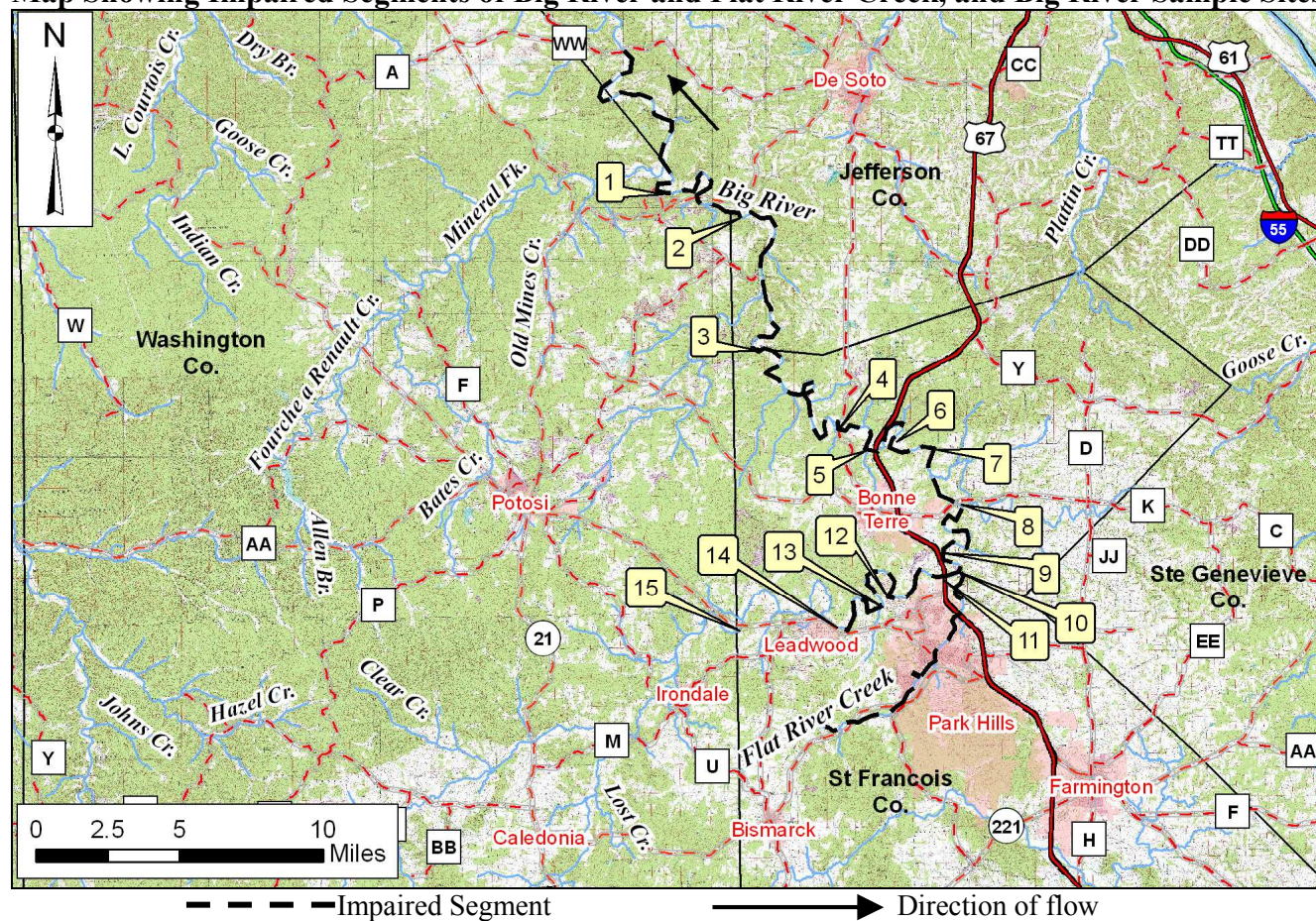


Figure 6

For related information, see the [Eaton Branch](#), [Shaw Branch](#) and [Turkey Creek](#) (in St. Francois County) Information Sheets. Shaw Branch is a tributary to Flat River Creek and the others are tributaries to Big River itself.

Map Showing Impaired Segments of Big River and Flat River Creek, and Big River Sample Sites

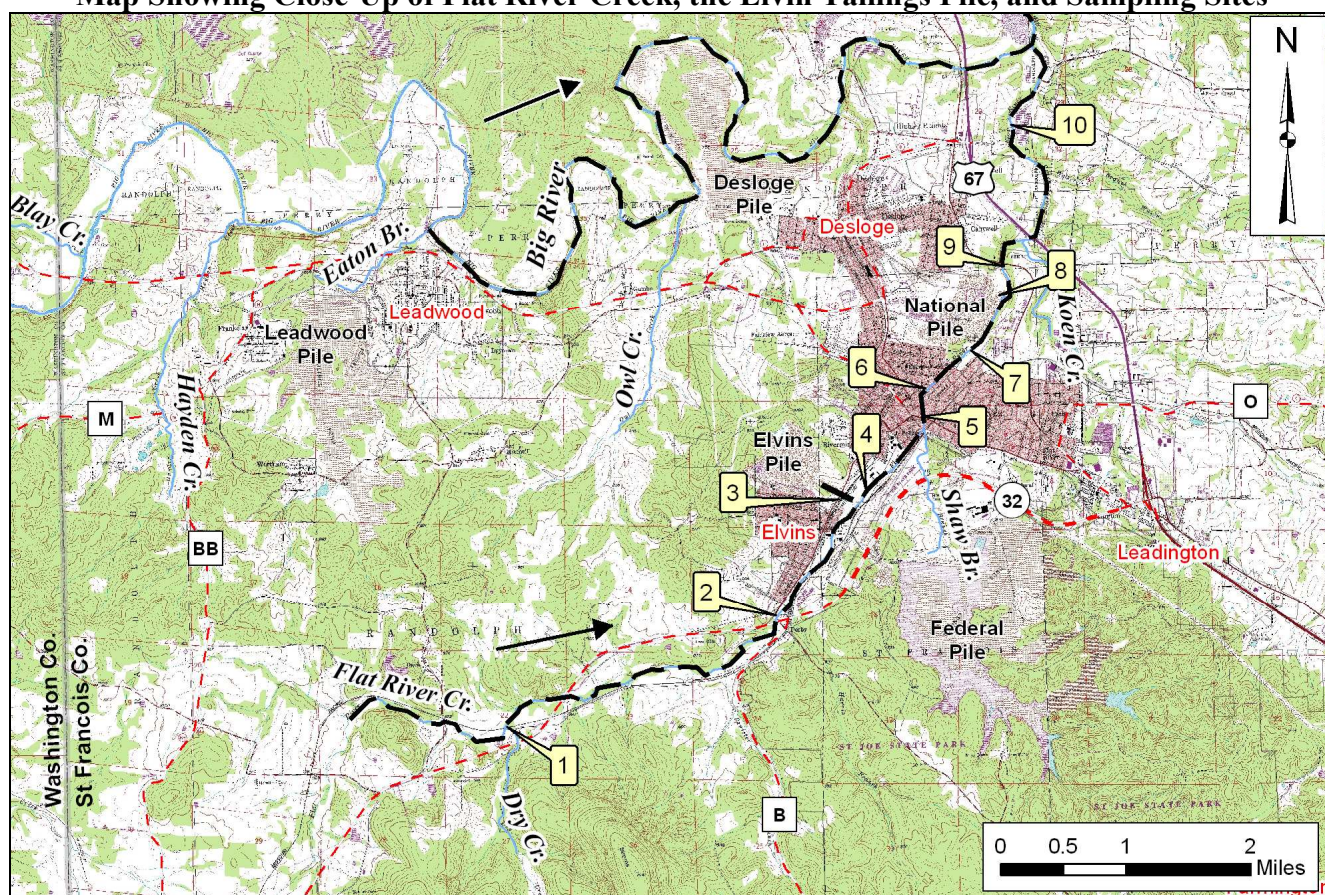


Sample Sites

- | | |
|--|---|
| 1 – Big R. @Washington State Park | 9 – Big River 1.2 mile below Flat River Cr. |
| 2 – Big R. downstream of Mill Creek | 10 – Big River just below Flat River Cr. |
| 3 – Big R. upstream of Mill Creek | 11 – Big River below Desloge |
| 4 – Big R. 0.1 mile below Turkey Cr. | 12 – Big R. just below Desloge TP |
| 5 – Big R. 0.2 mile above Turkey Cr. | 13 – Big River @ Bone Hole |
| 6 – Big River @ St Francois State Park | 14 – Big R. 0.7 mile below Eaton Br. |
| 7 – Big R. below Bonne Terre tailings | 15 – Big R. 2.5 miles above Eaton Br. |
| 8 – Big R. upstream of Bonne Terre | |

TP = tailings pile

Map Showing Close-Up of Flat River Creek, the Elvin Tailings Pile, and Sampling Sites



--- Impaired Segment

→ Direction of flow

Sample Sites

- | | |
|--|---|
| 1 – Flat River Cr. just below Dry Cr. | 6 – Flat River Cr. @ Flat River |
| 2 – Flat River Cr. @ Derby, MO. | 7 – Flat River Cr. just above National TP |
| 3 – Unclassified trib from Elvins tailings pile. | 8 – Flat River Cr. just below National TP tributary |
| 4 – Flat River Cr. just below Elvins TP trib. | 9 – Flat River Cr. below National tailings pile |
| 5 – Flat River Cr. @ Main Street, Flat River | 10 – Flat River Cr. near mouth |

TP = tailings pile

Also see the information sheet for Big River and Flat River Creek for dissolved lead, sediment and dissolved zinc (Flat River Creek only).

The final Big River et. al. TMDL will be based on the most current available data and information. For TMDL status or additional information, please contact the Water Protection Program.

For more information call or write:

Missouri Department of Natural Resources

Water Protection Program

P.O. Box 176, Jefferson City, MO 65102-0176

1-800-361-4827 or 573-751-1300 office

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Program Home Page: www.dnr.mo.gov/env/wpp/index.html